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(54) OLED DISPLAY DEVICE AND MANUFACTURING METHOD THEREOF

OLED-ANZEIGEVORRICHTUNG UND VERFAHREN ZUR HERSTELLUNG DAVON

DISPOSITIF D'AFFICHAGE OLED ET SON PROCÉDÉ DE FABRICATION

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(56) References cited:

CN-A- 101 562 192
CN-A- 105 470 409
CN-U- 202 003 622
DE-A1-102015 105 484
JP-A- 2006 259 307
JP-A- 2007 165 735
KR-B1- 100 634 676
US-A1- 2003 218 421

- **Jeong H.K.: "Metal-containing thin 1m encappsulation with exibility and heat transfer", journal of information display, vol. 16, no. 2, 9 June 2015 (2015-06-09), pages 123-128, XP055591674,**

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to the field of flat panel display technology and more particular to an organic light-emitting diode (OLED) display and a manufacturing method thereof.

2. The Related Arts

[0002] OLED displays possess advantages, such as being self-luminous, high brightness, wide view angle, high contrast, being flexible, and low power consumption, and thus attract much attention as a new generation of displaying solution that gradually takes the place of traditional liquid crystal displays. It is now a symbol of being high tech by adopting an OLED display panel from small size ones used in mobile phone display screens to large size ones used in high definition flat panel televisions.

[0003] The OLED based display technology is different from the traditional liquid crystal display technology in that no backlighting is necessary and an extremely thin organic material coating layer and a glass substrate are involved so that when an electrical current is conducted therethrough, the organic material emits light. However, the organic material is susceptible to reaction with moisture and oxygen and thus, a display based that is based on the organic material is subject to extremely severe requirement for packaging of an OLED display panel. Consequently, packaging an OLED device to improve sealing of the interior of the device and to achieve isolation from the external environment to the greatest extent would be indispensable to stable emission of light of the OLED device.

[0004] The most commonly adopted processes of packaging existing OLED device involve ultraviolet curable resin in combination with a rigid package plate (such as glass or metal) to cover the packaging. Such processes are not fit for flexible devices. Thus, technical solutions that are based on thin film encapsulation (TFE) that uses stacked films to package an OLED device have also been proposed and the related thin film encapsulation art is considered vital for flexible displaying is regarded as a mainstream technique in the future. On the other hand, massive results of study and research reveal deterioration of the performance of an OLED device is closely related to material degradation resulting from heat generated by the device itself. Thus, to effectively isolate external moisture and oxygen and to reduce heat-induced decomposition caused by the heat generated by a device are imperative factors for extension of the service life of the device.

[0005] Currently, the most widely used TFE techniques generally adopt an inorganic/organic/inorganic alternate structure, such as a thin film encapsulation structure disclosed in US Patent No. 8569951 B2 , this thin film encapsulation structure adopting a cyclically alternating arrangement of organics and inorganics, in which the inorganic layers function to block external moisture and oxygen, while the organic layers function for relief of stress and planarization covering of particulate substances. Soon afterwards, Samsung massively reported a series of secondary type TFE techniques, such as US2009/0252975 A1, US2015/0188084 A1, US2015/0153779 A1, and US2015/0079707 A1. However, it is known that such packaging techniques involve inorganic metal oxides and organic materials, of which thermal conductivity is generally poor, making it hard to conduct away heat generated by a device.

[0006] Korean institute of industrial research discloses in *Organic Electrics* an OLED device structure, in which a TFE structure comprises a multiple-layer structure including alternate polymer layers and aluminum oxide (Al_2O_3) layers and the TFE structure is finally provided, on a topmost layer, with a copper (Cu) heat dissipation plate. The OLED device that comprises the copper heat dissipation plate exhibits an operation temperature that is lower than that of a device having no such a copper heat dissipation plate. In addition, with the advance of operation time, the device with the copper heat dissipation plate shows a temperature increase trend that is significantly suppressed. Such a technique provides a better guidance solution for heat transfer of an OLED device. However, the transmission rate of Cu is not high enough, and, particularly for application in a top emission device in the display field, such a technique is subjected great limitation.

[0007] Korea Institute of Science and Technology reported in Journal of Information Display a thin film encapsulation technique involving a silver inlay layer. This thin film encapsulation technique uses a polymer that contains nanometer particulates of silicon as organic layers and aluminum oxide (Al_2O_3) as inorganic layers, with an extremely thin layer of silver (Ag) interposed between two Al_2O_3 inorganic layers and an additional layer of Ag placed on the topmost layer. A thin film encapsulation structure adopting such a technique would reduce water vapor transmission rate (WVPR) of the thin film to $10^{-5}g/m^2/d$. Also, the addition of Ag helps effectively transfer heat generated in the interior of the device so as to improve the stability of the device. However, covering Ag on an entire surface of the thin film in a top emission device would reduce outward emission of light so that such a heat conducting material suffers certain limitations. JP2006259307A proposes a display device comprising heat radiators and is a related art.

SUMMARY OF THE INVENTION

[0008] An objective of the present invention is to provide an organic light-emitting diode (OLED) display, which allows for effective transfer of heat generated during an operation of an OLED device, reduces thermal decomposition of a material of the OLED device, and extends the service life of the device while ensuring sufficient capability of the device in blocking external moisture and oxygen.

[0009] Another objective of the present invention is to provide a manufacturing method of an OLED display, which includes a patterned layer of high thermal conductivity in a thin film encapsulation structure to provide effective transfer of heat generated during an operation of an OLED device, reduce thermal decomposition of a material of the OLED device, and extend the service life of the device while ensuring sufficient capability of the device in blocking external moisture and oxygen.

[0010] To achieve the above objectives, the present invention provides an OLED display, which comprises an OLED substrate and a thin film encapsulation layer disposed on the OLED substrate;

> the thin film encapsulation layer comprising a first inorganic passivation layer disposed on the OLED substrate, a high thermal conductivity layer directly disposed on the first inorganic passivation layer, a first organic buffer layer directly disposed on the first inorganic passivation layer and the high thermal conductivity layer, and a second inorganic passivation layer directly disposed on the first organic buffer layer;
>
> the OLED substrate comprising a plurality of pixel units arranged in an array, each of the pixel units comprising a plurality of sub-pixel areas arranged in the array;
>
> the high thermal conductivity layer comprising a plurality of openings formed therein to correspond, in a one to one manner, to the plurality of the sub-pixel areas of the plurality of pixel units, the first organic buffer layer completely filling up the plurality of openings formed in the high thermal conductivity layer.

[0011] The high thermal conductivity layer comprises a material that comprises diamond-like carbon, silver, aluminum, aluminum nitride, graphene, or copper, the high thermal conductivity layer having a thickness of 1-1000 nm.

[0012] The thin film encapsulation layer further comprises a second organic buffer layer disposed on the second inorganic passivation layer and a third inorganic passivation layer disposed on the second organic buffer layer.

[0013] The first, second, and third inorganic passivation layers each comprise a material that comprises Al_2O_3, TiO_2, SiNx, SiCNx, or SiOx, the first, second, and third inorganic passivation layers each having a thickness of 0.5-1μm;
the first and second organic buffer layers each comprising a material that comprises hexamethyldisiloxane, polyacrylate polymers, polycarbonate polymers, or polystyrene, the first and second organic buffer layers each having a thickness of 4-8μm.

[0014] Each of the pixel units comprises four sub-pixel areas arranged in a 2×2 array, the four sub-pixel areas being respectively white, red, blue, and green sub-pixel areas.

[0015] The present invention also provides a manufacturing method of an OLED display, which comprises the following steps:

> Step 1: providing an OLED substrate, wherein the OLED substrate comprises a plurality of pixel units arranged in an array and each of the pixel units comprises a plurality of sub-pixel areas arranged in the array; and
> Step 2: forming a thin film encapsulation layer on the OLED substrate to provide an OLED display;
> wherein the thin film encapsulation layer is formed with a process that comprises the following steps:
> Step 21: depositing and forming a first inorganic passivation layer on the OLED substrate;
> Step 22: directly forming a high thermal conductivity layer on the first inorganic passivation layer, the high thermal conductivity layer comprising a plurality of openings that correspond, in a one to one manner, to the plurality of sub-pixel areas of the plurality of pixel units;
> Step 23: directly forming a first organic buffer layer on the first inorganic passivation layer and the high thermal conductivity layer such that the first organic buffer layer completely fills up the plurality of openings formed in the high thermal conductivity layer; and
> Step 24: directly depositing and forming a second inorganic passivation layer on the first organic buffer layer.
> Step 22 comprises applying vacuum deposition with a mask plate to direct form the high thermal conductivity layer that comprises the plurality of openings; or alternatively,
> applying plasma enhanced chemical vapor deposition (PECVD), atomic layer deposition (ALD), pulsed laser deposition (PLD), or sputtering to first deposit a thermally conductive layer and then, subjecting the thermally conductive film to treatment through photoengraving so as to form the plurality of openings in the thermally conductive film to thus provide the high thermal conductivity layer;
> wherein the high thermal conductivity layer comprises a material that comprises diamond-like carbon, silver, aluminum, aluminum nitride, graphene, or copper, and the high thermal conductivity layer has a thickness of 1-1000 nm.

[0016] The process with which the thin film encapsulation layer is formed further comprises:

> Step 25: forming a second organic buffer layer on

the second inorganic passivation layer; and

Step 26: depositing and forming a third inorganic passivation layer on the second organic buffer layer.

[0017] The first, second, and third inorganic passivation layers are each formed with PECVD, ALD, PLD, or sputtering; the first, second, and third inorganic passivation layers each comprise a material that comprises Al_2O_3, TiO_2, SiNx, SiCNx, or SiOx; and the first, second, and third inorganic passivation layers each have a thickness of 0.5-1μm;
wherein the first and second organic buffer layers are each formed with ink jet printing (IJP), PECVD, screen printing, or slot coating; the first and second organic buffer layers each comprise a material that comprises hexamethyldisiloxane, polyacrylate polymers, polycarbonate polymers, or polystyrene; and the first and second organic buffer layers each have a thickness of 4-8μm.

[0018] In the OLED substrate provided in Step 1, each of the pixel units comprises four sub-pixel areas arranged in a 2×2 array and the four sub-pixel areas are respectively white, red, blue, and green sub-pixel areas.

[0019] The efficacy of the present invention is that the present invention provides an OLED display, which comprises an OLED substrate and a thin film encapsulation layer disposed on the OLED substrate, wherein the thin film encapsulation layer comprises a patterned high thermal conductivity layer and the high thermal conductivity layer is provided with a plurality of openings formed therein to correspond, in a one to one manner, to a plurality of sub-pixel areas of the OLED substrate so as to prevent the high thermal conductivity layer from absorbing light and also help eliminate the constraint that a top emission device is only allowed to use a material having a high transmission rate, thereby allowing for effective transfer of heat generated during an operation of an OLED device without deteriorating light emission efficiency of the device, reducing thermal decomposition of a material of the OLED device, and ensuring the device possesses sufficiency capability of blocking external moisture and oxygen to thus extend the service life of the device; and the present invention provides a manufacturing method of an OLED display, which adopts thin film encapsulation to package an OLED device and adds a patterned high thermal conductivity layer in the thin film encapsulation structure, wherein the high thermal conductivity layer is provided with a plurality of openings formed therein to correspond, in a one to one manner, to a plurality of subpixel areas of the OLED substrate so as to prevent the high thermal conductivity layer from absorbing light and also help eliminate the constraint that a top emission device is only allowed to use a material having a high transmission rate, thereby allowing for effective transfer of heat generated during an operation of an OLED device without deteriorating light emission efficiency of the device, reducing thermal decomposition of a material of the OLED device, and ensuring the device possesses sufficiency capability of blocking external moisture and oxygen to thus extend the service life of the device.

[0020] For better understanding of the features and technical contents of the present invention, reference will be made to the following detailed description of the present invention and the attached drawings. However, the drawings are provided only for reference and illustration and are not intended to limit the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] The technical solution, as well as other beneficial advantages, of the present invention will become apparent from the following detailed description of embodiments of the present invention, with reference to the attached drawings.

[0022] In the drawings:

FIG. 1 is a schematic view showing the structure of a first embodiment of an organic light-emitting diode (OLED) display according to the present invention.

FIG. 2 is a schematic view showing the structure of a second embodiment of the OLED display according to the present invention.

FIG. 3 is a flow chart illustrating a manufacturing method of an OLED display according to the present invention;

FIG. 4 is a schematic view illustrating Step 21 of the manufacturing method of the OLED display according to the present invention;

FIG. 5 is a schematic view illustrating Step 22 of the manufacturing method of the OLED display according to the present invention;

FIG. 6 is a schematic view illustrating Step 23 of the manufacturing method of the OLED display according to the present invention; and

FIG. 7 is a schematic view illustrating Step 25 of a second embodiment of the manufacturing method of the OLED display according to the present invention;

DETAILED DESCRIPTOIN OF THE PREFERRED EMBODIMENTS

[0023] To further expound the technical solution adopted in the present invention and the advantages thereof, a detailed description will be given with reference to the preferred embodiments of the present invention and the drawings thereof.

[0024] Referring to FIG. 1, which is a schematic view showing the structure of a first embodiment of an organic light-emitting diode (OLED) display according to the present invention. In the instant embodiment, the OLED display comprises an OLED substrate 101 and a thin film encapsulation layer disposed on the OLED substrate 101.

[0025] The thin film encapsulation layer comprises a first inorganic passivation layer 201 disposed on the OLED substrate 101, a high thermal conductivity layer 301 directly disposed on the first inorganic passivation layer 201, a first organic buffer layer 401 directly disposed on the first inorganic passivation layer 201 and the high thermal conductivity layer 301, and a second inorganic passivation layer 202 2. directly disposed on the first organic buffer layer 401.

[0026] The OLED substrate 101 comprises a plurality of pixel units arranged in an array. Each of the pixel units comprises a plurality of sub-pixel areas arranged in the array.

[0027] The high thermal conductivity layer 301 is provided with a plurality of openings 3011 formed therein to correspond, in a one to one manner, to the plurality of the sub-pixel areas of the plurality of pixel units. The first organic buffer layer 401 completely fills up the plurality of openings 3011 formed in the high thermal conductivity layer 301.

[0028] Specifically, in the present invention, the plurality of openings 3011 of the high thermal conductivity layer 301 are arranged in a manner identical to the arrangement of the plurality of sub-pixel areas of the plurality of pixel units and each of the openings 3011 has a size consistent with a size of the corresponding one of the sub-pixel areas so as to prevent the high thermal conductivity layer 301 from absorbing light emitting from the sub-pixel areas and also help eliminate the constraint that a top emission device is only allowed to use a material having a high transmission rate, thereby allowing for effective transfer of heat generated during an operation of an OLED device without deteriorating light emission efficiency of the device, reducing thermal decomposition of a material of the OLED device, and ensuring the device possesses sufficiency capability of blocking external moisture and oxygen to thus extend the service life of the device.

[0029] Specifically, in the instant embodiment, each of the pixel units comprises four sub-pixel areas arranged in a 2×2 array. The four sub-pixel areas are respectively white, red, blue, and green sub-pixel areas. Each of the openings 3011 that corresponds to the white sub-pixel area has a size consistent with a size of the white sub-pixel area; and similarly, the openings 3011 that correspond to the red, blue, and green sub-pixel areas have sizes respectively consistent with sizes of the red, blue, and green sub-pixel areas.

[0030] Specifically, the high thermal conductivity layer 301 comprises a material that is a metallic or non-metal high thermal conductivity material, such as diamond-like carbon (DLC), silver, aluminum (Al), aluminum nitride (AlN), graphene, and copper.

[0031] Specifically, the high thermal conductivity layer 301 has a thickness of 1-1000 nm.

[0032] Specifically, the first and second inorganic passivation layers 201, 202 comprise a material that is a material for blocking external moisture and oxygen, such as Al_2O_3, titanium oxide (TiO_2), silicon nitride (SiNx), silicon carbon nitride (SiCNx), and silicon oxide (SiOx).

[0033] Specifically, the first and second inorganic passivation layers 201, 202 each have a thickness of 0.5-1μm.

[0034] Specifically, the first organic buffer layer 401 comprises a material that is a material for stress relief and covering particulates, such as hexamethyldisiloxane (HMDSO), polyacrylate polymers (such as acrylic), polycarbonate polymers, and polystyrene.

[0035] Specifically, the first organic buffer layer 401 has a thickness of 4-8μm.

[0036] Referring to FIG. 2, which is a schematic view showing a structure of a second embodiment of an OLED display according to the present invention, compared to the first embodiment described above, the thin film encapsulation layer further comprises a second organic buffer layer 402 disposed on the second inorganic passivation layer 202 and a third inorganic passivation layer 203 disposed on the second organic buffer layer 402. In this embodiment, the second organic buffer layer 402 and the first organic buffer layer 401 comprise a material comprising hexamethyldisiloxane, polyacrylate polymers, polycarbonate polymers, or polystyrene; and the second organic buffer layer 402 and the first organic buffer layer 401 each have a thickness of 4-8μm. The third inorganic passivation layer 203 and the first and second inorganic passivation layers 201, 202 comprise a material comprising Al_2O_3, TiO_2, SiNx, SiCNx, or SiOx; and the third inorganic passivation layer 203 and the first and second inorganic passivation layers 201, 202 each have a thickness of 0.5-μm. The remaining is the same as those of the first embodiment described above and thus, repeated description is omitted herein.

[0037] Based on the OLED display described above, reference being had to FIG. 3, the present invention further provides a manufacturing method of an OLED display, of which a first example specifically comprises the following steps:

Step 1: providing an OLED substrate 101, wherein the OLED substrate 101 comprises a plurality of pixel units arranged in an array and each of the pixel units comprises a plurality of sub-pixel areas arranged in the array.

Step 2: forming a thin film encapsulation layer on the OLED substrate 101 to provide an OLED display;

wherein the thin film encapsulation layer is formed through a process that comprises the following steps:

Step 21: as shown in FIG. 4, applying plasma enhanced chemical vapor deposition (PECVD), atomic layer deposition (ALD), pulsed laser deposition (PLD), or sputtering to deposit and form a first inorganic passivation layer 201 on the OLED substrate 101.

[0038] Specifically, the first inorganic passivation layer 201 comprises a material that is a material for blocking external moisture and oxygen, such as Al_2O_3, TiO_2, SiNx, SiCNx, and SiOx.

[0039] Specifically, the first inorganic passivation layer 201 has a thickness of 0.5-1μm.

[0040] Step 22: as shown in FIG. 5, directly forming a high thermal conductivity layer 301 on the first inorganic passivation layer 201, the high thermal conductivity layer 301 comprising a plurality of openings 3011 that correspond, in a one to one manner, to the plurality of sub-pixel areas of the plurality of pixel units.

[0041] Specifically, Step 22 comprises applying vacuum deposition with a mask plate to direct form the high thermal conductivity layer 301 that comprises the plurality of openings 3011; or alternatively,

applying various metal or non-metal deposition processes, such as PECVD, ALD, PLD, and sputtering, to first deposit a thermally conductive layer and then, subjecting the thermally conductive film to treatment through photoengraving so as to form the plurality of openings 3011 in the thermally conductive film to thus provide the high thermal conductivity layer 301.

[0042] Specifically, in the present invention, the plurality of openings 3011 of the high thermal conductivity layer 301 are arranged in a manner identical to the arrangement of the plurality of sub-pixel areas of the plurality of pixel units and each of the openings 3011 has a size consistent with a size of the corresponding one of the sub-pixel areas so as to prevent the high thermal conductivity layer 301 from absorbing light emitting from the sub-pixel areas and also help eliminate the constraint that a top emission device is only allowed to use a material having a high transmission rate, thereby allowing for effective transfer of heat generated during an operation of an OLED device without deteriorating light emission efficiency of the device, reducing thermal decomposition of a material of the OLED device, and ensuring the device possesses sufficiency capability of blocking external moisture and oxygen to thus extend the service life of the device.

[0043] Specifically, in the instant embodiment, each of the pixel units comprises four sub-pixel areas arranged in a 2$\times$2 array. The four sub-pixel areas are respectively white, red, blue, and green sub-pixel areas. Each of the openings 3011 that corresponds to the white sub-pixel area has a size consistent with a size of the white sub-pixel area; and similarly, the openings 3011 that correspond to the red, blue, and green sub-pixel areas have sizes respectively consistent with sizes of the red, blue, and green sub-pixel areas.

[0044] Specifically, the high thermal conductivity layer 301 comprises a material that is a metallic or non-metal high thermal conductivity material, such as diamond-like carbon, silver, aluminum, aluminum nitride, graphene, and copper.

[0045] Specifically, the high thermal conductivity layer 301 has a thickness of 1-1000 nm.

[0046] Step 23, as shown in FIG. 6, applying ink jet printing (IJP), PECVD, screen printing, or slot coating to form a first organic buffer layer 401 directly on the first inorganic passivation layer 201 and the high thermal conductivity layer 301 such that the first organic buffer layer 401 completely fills up the plurality of openings 3011 formed in the high thermal conductivity layer 301.

[0047] Specifically, the first organic buffer layer 401 comprises a material that is a material for stress relief and covering particulates, such as hexamethyldisiloxane, polyacrylate polymers (such as acrylic), polycarbonate polymers, and polystyrene.

[0048] Specifically, the first organic buffer layer 401 has a thickness of 4-8μm.

[0049] Step 24: applying PECVD, ALD, PLD, or sputtering to deposit and form a second inorganic passivation layer 202 directly on the first organic buffer layer 401 so as to provide an OLED display shown in FIG. 1.

[0050] Specifically, the second inorganic passivation layer 202 comprises a material that is a material for blocking external moisture and oxygen, such as Al_2O_3, TiO_2, SiNx, SiCNx, and SiOx; and the second inorganic passivation layer 202 has a thickness of 0.5-1μm.

[0051] A second example of the manufacturing method of an OLED display according to the present invention, when compared to the first example described above, involves a process of forming the thin film encapsulation layer that further comprises:

[0052] Step 25: as shown in FIG. 7, coating and forming a second organic buffer layer 402 on the second inorganic passivation layer 202.

[0053] Specifically, the second organic buffer layer 402 and the first organic buffer layer 401 are each formed with UP, PECVD, screen printing, or slot coating; the second organic buffer layer 402 and the first organic buffer layer 401 comprises a material comprising hexamethyldisiloxane, polyacrylate polymers, polycarbonate polymers, or polystyrene; and the second organic buffer layer 402 and the first organic buffer layer 401 each have a thickness of 4-8μm.

[0054] Step 26: coating and forming a third inorganic passivation layer 203 on the second organic buffer layer 402 so as to provide an OLED display as shown in FIG. 2.

[0055] Specifically, the third inorganic passivation layer 203 and the first and second inorganic passivation layers 201, 202 are each formed with PECVD, ALD, PLD, or sputtering; the third inorganic passivation layer 203 and the first and second inorganic passivation layers 201, 202 each comprise a material that comprising Al_2O_3, TiO_2, SiNx, SiCNx, or SiOx; and the third inorganic passivation layer 203 and the first and second inorganic passivation layers 201, 202 each have a thickness of

0.5-1μm.

[0056] In summary, the present invention provides an OLED display, which comprises an OLED substrate and a thin film encapsulation layer disposed on the OLED substrate, wherein the thin film encapsulation layer comprises a patterned high thermal conductivity layer and the high thermal conductivity layer is provided with a plurality of openings formed therein to correspond, in a one to one manner, to a plurality of sub-pixel areas of the OLED substrate so as to prevent the high thermal conductivity layer from absorbing light and also help eliminate the constraint that a top emission device is only allowed to use a material having a high transmission rate, thereby allowing for effective transfer of heat generated during an operation of an OLED device without deteriorating light emission efficiency of the device, reducing thermal decomposition of a material of the OLED device, and ensuring the device possesses sufficiency capability of blocking external moisture and oxygen to thus extend the service life of the device; and the present invention provides a manufacturing method of an OLED display, which adopts thin film encapsulation to package an OLED device and adds a patterned high thermal conductivity layer in the thin film encapsulation structure, wherein the high thermal conductivity layer is provided with a plurality of openings formed therein to correspond, in a one to one manner, to a plurality of sub-pixel areas of the OLED substrate so as to prevent the high thermal conductivity layer from absorbing light and also help eliminate the constraint that a top emission device is only allowed to use a material having a high transmission rate, thereby allowing for effective transfer of heat generated during an operation of an OLED device without deteriorating light emission efficiency of the device, reducing thermal decomposition of a material of the OLED device, and ensuring the device possesses sufficiency capability of blocking external moisture and oxygen to thus extend the service life of the device.

[0057] Based on the description given above, those having ordinary skills in the art may easily contemplate various changes and modifications of the technical solution and the technical ideas of the present invention. All these changes and modifications are considered belonging to the protection scope of the present invention as defined in the appended claims.

Claims

1. An organic light-emitting diode, OLED, display, wherein the OLED

   display comprises an OLED substrate (101) and a thin film encapsulation layer disposed on the OLED substrate (101);
   the thin film encapsulation layer comprising a first inorganic passivation layer (201) disposed on the OLED substrate (101), a high thermal conductivity layer (301) directly disposed on the first inorganic passivation layer (201), a first organic buffer layer (401) directly disposed on the first inorganic passivation layer (201) and the high thermal conductivity layer (301), and a second inorganic passivation layer (202) directly disposed on the first organic buffer layer (401);
   the OLED substrate (101) comprising a plurality of pixel units arranged in an array, each of the pixel units comprising a plurality of sub-pixel areas arranged in the array;
   the high thermal conductivity layer (301) comprising a plurality of openings (3011) formed therein to correspond, in a one to one manner, to the plurality of the
   sub-pixel areas of the plurality of pixel units, the first organic buffer layer (401) completely filling up the plurality of openings (3011) formed in the high thermal conductivity layer (301).

2. The OLED display as claimed in Claim 1, wherein the high thermal
   conductivity layer (301) comprises a material that comprises diamond-like carbon, silver, aluminum, aluminum nitride, graphene, or copper, the high thermal conductivity layer (301) having a thickness of 1-1000 nm.

3. The OLED display as claimed in Claim 1, wherein the thin film
   encapsulation layer further comprises a second organic buffer layer (402) disposed on the second inorganic passivation layer (202) and a third inorganic passivation layer (203) disposed on the second organic buffer layer (402).

4. The OLED display as claimed in Claim 3, wherein the first, second,

   and third inorganic passivation layers (201, 202, 203) each comprise a material that comprises Al_2O_3, TiO_2, SiNx, SiCNx, or SiOx, the first, second, and third inorganic passivation layers (201, 202, 203) each having a thickness of 0.5-1μm
   the first and second organic buffer layers (401, 402) each comprising a material that comprises hexamethyldisiloxane, polyacrylate polymers, polycarbonate polymers, or polystyrene, the first and second organic buffer layers (401, 402) each having a thickness of 4-8μm.

5. The OLED display as claimed in Claim 1, wherein each of the pixel
   units comprises four sub-pixel areas arranged in a 2×2 array, the four sub-pixel areas being respectively white, red, blue, and green sub-pixel areas.

6. A manufacturing method of an organic light-emitting

diode (OLED) display, wherein the manufacturing method of the OLED display comprises the following steps:

Step 1: providing an OLED substrate (101), wherein the OLED substrate (101) comprises a plurality of pixel units arranged in an array and each of the pixel units comprises a plurality of sub-pixel areas arranged in the array; and
Step 2: forming a thin film encapsulation layer on the OLED substrate (101) to provide an OLED display;
wherein the thin film encapsulation layer is formed with a process that comprises the following steps:

Step 21: depositing and forming a first inorganic passivation layer (201) on the OLED substrate (101);
Step 22: directly forming a high thermal conductivity layer (301) on the first inorganic passivation layer (201), the high thermal conductivity layer (301) comprising a plurality of openings (3011) that correspond, in a one to one manner, to

the plurality of sub-pixel areas of the plurality of pixel units;
Step 23: directly forming a first organic buffer layer (401) on the first inorganic passivation layer (201) and the high thermal conductivity layer (301) such that the first organic buffer layer (401) completely fills up the plurality of openings (3011) formed in the high thermal conductivity layer (301); and
Step 24: directly depositing and forming a second inorganic passivation layer (202) on the first organic buffer layer (401).

7. The manufacturing method of the OLED display as claimed in Claim 6, wherein

Step 22 comprises applying vacuum deposition with a mask plate to direct form the high thermal conductivity layer (301) that comprises the plurality of openings (3011); or alternatively,
applying plasma enhanced chemical vapor deposition (PECVD), atomic layer deposition (ALD), pulsed laser deposition (PLD), or sputtering to first deposit a thermally conductive layer and then, subjecting the thermally conductive film to treatment through photoengraving so as to form the plurality of openings (3011) in the thermally conductive film to thus provide the high thermal conductivity layer (301);
wherein the high thermal conductivity layer (301) comprises a material that comprises diamond-like carbon, silver, aluminum, aluminum nitride, graphene, or copper, and the high thermal conductivity layer (301) has a thickness of 1-1000 nm.

8. The manufacturing method of the OLED display as claimed in Claim 6, wherein the process with which the thin film encapsulation layer is formed further comprises:

Step 25: forming a second organic buffer layer (402) on the second inorganic passivation layer (202); and
Step 26: depositing and forming a third inorganic passivation layer (203) on the second organic buffer layer (402).

9. The manufacturing method of the OLED display as claimed in Claim 8, wherein

the first, second, and third inorganic passivation layers (201, 202, 203) are each formed with PECVD, ALD, PLD, or sputtering; the first, second, and third inorganic passivation layers (201, 202, 203) each comprise a material that comprises Al_2O_3, TiO_2, SiNx, SiCNx, or SiOx; and the first, second, and third inorganic passivation layers (201, 202, 203) each have a thickness of 0.5-1μm
wherein the first and second organic buffer layers (401, 402) are each formed with ink jet printing (IJP), PECVD, screen printing, or slot coating; the first and second organic buffer layers (401, 402) each comprise a material that comprises hexamethyldisiloxane, polyacrylate polymers, polycarbonate polymers, or polystyrene; and the first and second organic buffer layers (401, 402) each have a thickness of 4-8μm.

10. The manufacturing method of the OLED display as claimed in Claim 6, wherein,
in the OLED substrate (101) provided in Step 1, each of the pixel units comprises four sub-pixel areas arranged in a 2×2 array and the four sub-pixel areas are respectively white, red, blue, and green sub-pixel areas.

Patentansprüche

1. Organische-lichtemittierende-Dioden-, OLED-, Anzeige, wobei die OLED-Anzeige ein OLED-Substrat (101) und eine auf dem OLED-Substrat (101) angeordnete Dünnfilm-Verkapselungsschicht umfasst;

wobei die Dünnfilm-Verkapselungsschicht eine erste anorganische Passivierungsschicht (201), die auf dem OLED-Substrat (101) angeordnet ist, eine Schicht (301) mit hoher Wärmeleitfä-

higkeit, die direkt auf der ersten anorganischen Passivierungsschicht (201) angeordnet ist, eine erste organische Pufferschicht (401), die direkt auf der ersten anorganischen Passivierungsschicht (201) und der Schicht (301) mit hoher Wärmeleitfähigkeit angeordnet ist, und eine zweite anorganische Passivierungsschicht (202), die direkt auf der ersten organischen Pufferschicht (401) angeordnet ist, umfasst;
wobei das OLED-Substrat (101) eine Vielzahl von in einer Matrix angeordneten Pixeleinheiten umfasst, wobei jede der Pixeleinheiten eine Vielzahl von in der Matrix angeordneten Sub-Pixelbereichen umfasst;
wobei die Schicht (301) mit hoher Wärmeleitfähigkeit eine Vielzahl von Öffnungen (3011) aufweist, die derart in der Schicht mit hoher Wärmeleitfähigkeit ausgeformt sind, dass sie eins zu eins der Vielzahl der Sub-Pixelbereiche der Vielzahl von Pixeleinheiten entsprechen, wobei die erste organische Pufferschicht (401) die Vielzahl von Öffnungen (3011), die in der Schicht (301) mit hoher Wärmeleitfähigkeit ausgebildet sind, vollständig auffüllt.

2. OLED-Anzeige nach Anspruch 1, wobei die Schicht (301) mit hoher Wärmeleitfähigkeit ein Material umfasst, das diamantartigen Kohlenstoff, Silber, Aluminium, Aluminiumnitrid, Graphen oder Kupfer umfasst, wobei die Schicht (301) mit hoher Wärmeleitfähigkeit eine Dicke von 1-1000 nm aufweist.

3. OLED-Anzeige nach Anspruch 1, wobei die Dünnfilm-Verkapselungsschicht ferner eine zweite organische Pufferschicht (402), die auf der zweiten anorganischen Passivierungsschicht (202) angeordnet ist, und eine dritte anorganische Passivierungsschicht (203), die auf der zweiten organischen Pufferschicht (402) angeordnet ist, umfasst.

4. OLED-Anzeige nach Anspruch 3, wobei die erste, zweite und dritte anorganische Passivierungsschicht (201, 202, 203) jeweils ein Material umfassen, das Al_2O_3 , TiO_2 , SiNx, SiCNx oder SiOx umfasst, wobei die erste, zweite und dritte anorganische Passivierungsschicht (201, 202, 203) jeweils eine Dicke von 0,5-1 μm aufweisen;
wobei die erste und die zweite organische Pufferschicht (401, 402) jeweils ein Material umfassen, das Hexamethyldisiloxan, Polyacrylatpolymere, Polycarbonatpolymere oder Polystyrol aufweist, wobei die erste und die zweite organische Pufferschicht (401, 402) jeweils eine Dicke von 4-8 μm aufweisen.

5. OLED-Anzeige nach Anspruch 1, wobei jede der Pixeleinheiten vier Sub-Pixelbereiche umfasst, die in einer 2×2-Matrix angeordnet sind, wobei die vier Sub-Pixelbereiche jeweils weiße, rote, blaue und grüne Sub-Pixelbereiche sind.

6. Verfahren zur Herstellung einer organischen-lichtemittierenden-Dioden-(OLED)-Anzeige, wobei das Verfahren zur Herstellung der OLED-Anzeige die folgenden Schritte umfasst:

Schritt 1: Bereitstellen eines OLED-Substrats (101), wobei das OLED-Substrat (101) eine Vielzahl von in einer Matrix angeordneten Pixeleinheiten umfasst und jede der Pixeleinheiten eine Vielzahl von in der Matrix angeordneten Sub-Pixelbereichen umfasst; und
Schritt 2: Bilden einer Dünnfilm-Verkapselungsschicht auf dem OLED-Substrat (101), um eine OLED-Anzeige bereitzustellen;
wobei die Dünnfilm-Verkapselungsschicht mit einem Verfahren gebildet wird, das die folgenden Schritte umfasst:

Schritt 21: Abscheiden und Bilden einer ersten anorganischen Passivierungsschicht (201) auf dem OLED-Substrat (101);
Schritt 22: Ausbilden einer Schicht (301) mit hoher Wärmeleitfähigkeit direkt auf der ersten anorganischen Passivierungsschicht (201), wobei die Schicht (301) mit hoher Wärmeleitfähigkeit eine Vielzahl von Öffnungen (3011) aufweist, die eins zu eins der Vielzahl von Sub-Pixelbereichen der Vielzahl von Pixeleinheiten entsprechen;
Schritt 23: Ausbilden einer ersten organischen Pufferschicht (401) direkt auf der ersten anorganischen Passivierungsschicht (201) und der Schicht (301) mit hoher Wärmeleitfähigkeit, so dass die erste organische Pufferschicht (401) die Vielzahl der in der Schicht (301) mit hoher Wärmeleitfähigkeit ausgebildeten Öffnungen (3011) vollständig auffüllt; und
Schritt 24: Abscheiden und Bilden einer zweiten anorganischen Passivierungsschicht (202) direkt auf der ersten organischen Pufferschicht (401).

7. Herstellungsverfahren für die OLED-Anzeige nach Anspruch 6, wobei Schritt 22 die Anwendung einer Vakuumabscheidung mit einer Maskenplatte umfasst, um die Schicht (301) mit hoher Wärmeleitfähigkeit, die die Vielzahl von Öffnungen (3011) umfasst, direkt auszubilden; oder alternativ,

Anwenden von plasmagestützter chemischer Dampfphasenabscheidung (PECVD), Atomlagenabscheidung (ALD), gepulster Laserabscheidung (PLD) oder Sputtern, um zunächst eine wärmeleitende Schicht abzuscheiden, und anschließendes Unterziehen des wärmeleiten-

den Films einer Behandlung durch Fotogravur, um die Vielzahl von Öffnungen (3011) in dem wärmeleitenden Film auszubilden, um die Schicht (301) mit hoher Wärmeleitfähigkeit bereitzustellen;
wobei die Schicht (301) mit hoher Wärmeleitfähigkeit ein Material umfasst, das diamantartigen Kohlenstoff, Silber, Aluminium, Aluminiumnitrid, Graphen oder Kupfer umfasst, und die Schicht (301) mit hoher Wärmeleitfähigkeit eine Dicke von 1-1000 nm aufweist.

8. Herstellungsverfahren für die OLED-Anzeige nach Anspruch 6, wobei das Verfahren, mit dem die Dünnfilm-Verkapselungsschicht gebildet wird, ferner umfasst:

Schritt 25: Bilden einer zweiten organischen Pufferschicht (402) auf der zweiten anorganischen Passivierungsschicht (202); und
Schritt 26: Abscheiden und Bilden einer dritten anorganischen Passivierungsschicht (203) auf der zweiten organischen Pufferschicht (402).

9. Herstellungsverfahren für die OLED-Anzeige nach Anspruch 8, wobei die erste, zweite und dritte anorganische Passivierungsschicht (201, 202, 203) jeweils durch PECVD, ALD, PLD oder Sputtern gebildet werden; wobei die erste, zweite und dritte anorganische Passivierungsschicht (201, 202, 203) jeweils ein Material umfassen, das Al_2O_3 , TiO_2, SiNx, SiCNx oder SiOx umfasst; und die erste, zweite und dritte anorganische Passivierungsschicht (201, 202, 203) jeweils eine Dicke von 0.5-1 μm aufweisen;
wobei die erste und die zweite organische Pufferschicht (401, 402) jeweils mit Tintenstrahldruck (IJP), PECVD, Siebdruck oder Schlitzdüsenbeschichtung gebildet werden; wobei die erste und die zweite organische Pufferschicht (401, 402) jeweils ein Material umfassen, das Hexamethyldisiloxan, Polyacrylatpolymere, Polycarbonatpolymere oder Polystyrol aufweist; und die erste und die zweite organische Pufferschicht (401, 402) jeweils eine Dicke von 4-8 μm aufweisen.

10. Herstellungsverfahren für die OLED-Anzeige nach Anspruch 6, wobei in dem in Schritt 1 bereitgestellten OLED-Substrat (101) jede der Pixeleinheiten vier Sub-Pixelbereiche umfasst, die in einer 2×2-Matrix angeordnet sind, und die vier Sub-Pixelbereiche jeweils weiße, rote, blaue und grüne Sub-Pixelbereiche sind.

Revendications

1. Affichage à diodes électroluminescentes organiques, DELO, dans lequel l'affichage DELO comprend un substrat DELO (101) et une couche d'encapsulation à film mince disposée sur le substrat DELO (101) ;

la couche d'encapsulation à film mince comprenant une première couche de passivation inorganique (201) disposée sur le substrat DELO (101), une couche à haute conductivité thermique (301) directement disposée sur la première couche de passivation inorganique (201), une première couche séparateur organique (401) directement disposée sur la première couche de passivation inorganique (201) et la couche à haute conductivité thermique (301), et une seconde couche de passivation inorganique (202) directement disposée sur la première couche séparateur organique (401) ;
le substrat DELO (101) comprenant une pluralité d'unités de pixel agencées dans une matrice, chacune des unités de pixel comprenant une pluralité de zones de sous-pixel agencées dans la matrice;
la couche à haute conductivité thermique (301) comprenant une pluralité d'ouvertures (3011) formées dans celle-ci pour correspondre, d'une manière univoque, à la pluralité des zones de sous-pixels de la pluralité d'unités de pixels, la première couche séparateur organique (401) remplissant complètement la pluralité d'ouvertures (3011) formées dans la couche à haute conductivité thermique (301).

2. Affichage DELO selon la revendication 1, dans lequel la couche à haute conductivité thermique (301) comprend un matériau qui comprend du carbone de type diamant, de l'argent, de l'aluminium, du nitrure d'aluminium, du graphène ou du cuivre, la couche à haute conductivité thermique (301) ayant une épaisseur de 1 à 1000 nm.

3. Affichage DELO selon la revendication 1, dans lequel la couche d'encapsulation à film mince comprend en outre une deuxième couche séparateur organique (402) disposée sur la deuxième couche de passivation inorganique (202) et une troisième couche de passivation inorganique (203) disposée sur la deuxième couche séparateur organique (402).

4. Affichage DELO selon la revendication 3, dans lequel les première, deuxième et troisième couches de passivation inorganiques (201, 202, 203) comprennent chacune un matériau qui comprend Al_2O_3 , TiO_2 , SiNx, SiCNx ou SiOx, les première, deuxième et troisième couches de passivation inorganiques (201, 202, 203) ayant chacune une épaisseur de 0,5-1 μm;
les première et seconde couches séparateur organiques (401, 402) comprenant chacune un matériau

qui comprend de l'hexaméthyldisiloxane, des polymères de polyacrylate, des polymères de polycarbonate ou du polystyrène, les première et seconde couches séparateur organiques (401, 402) ayant chacune une épaisseur de 4-8 μm.

5. Affichage DELO selon la revendication 1, dans lequel chacune des unités de pixel comprend quatre zones de sous-pixel agencées dans une matrice 2x2, les quatre zones de sous-pixel étant respectivement des zones de sous-pixel blanches, rouges, bleues et vertes.

6. Procédé de fabrication d'un affichage à diodes électroluminescentes organiques (DELO), dans lequel le procédé de fabrication de l'affichage DELO comprend les étapes suivantes :

Etape 1 : fourniture d'un substrat DELO (101), dans lequel le substrat DELO (101) comprend une pluralité d'unités de pixel agencées dans une matrice et chacune des unités de pixel comprend une pluralité de zones de sous-pixel agencées dans la matrice ; et
Étape 2 : formation d'une couche d'encapsulation à film mince sur le substrat DELO (101) pour fournir un affichage DELO ;
dans lequel la couche d'encapsulation à film mince est formée avec un procédé qui comprend les étapes suivantes :

Étape 21 : dépôt et formation d'une première couche de passivation inorganique (201) sur le substrat DELO (101) ;
Etape 22 : formation directe d'une couche à haute conductivité thermique (301) sur la première couche de passivation inorganique (201), la couche à haute conductivité thermique (301) comprenant une pluralité d'ouvertures (3011) qui correspondent, de manière univoque, à la pluralité de zones de sous-pixels de la pluralité d'unités de pixels ;
Etape 23 : formation directe d'une première couche séparateur organique (401) sur la première couche de passivation inorganique (201) et la couche à haute conductivité thermique (301) de telle sorte que la première couche séparateur organique (401) remplisse complètement la pluralité d'ouvertures (3011) formées dans la couche à haute conductivité thermique (301) ; et
Etape 24 : dépôt et formation directs d'une seconde couche de passivation inorganique (202) sur la première couche séparateur organique (401).

7. Procédé de fabrication de l'affichage DELO selon la revendication 6, dans lequel l'étape 22 comprend l'application d'un dépôt sous vide avec une plaque de masque pour former directement la couche à haute conductivité thermique (301) qui comprend la pluralité d'ouvertures (3011) ; ou alternativement,

l'application d'un dépôt chimique en phase vapeur amélioré par plasma (PECVD), d'un dépôt de couche atomique (ALD), d'un dépôt par laser pulsé (PLD) ou d'une pulvérisation pour déposer d'abord une couche thermoconductrice et ensuite, la soumission du film thermoconducteur à un traitement par photogravure de façon à former la pluralité d'ouvertures (3011) dans le film thermoconducteur pour fournir ainsi la couche à haute conductivité thermique (301) ;
dans lequel la couche à haute conductivité thermique (301) comprend un matériau qui comprend du carbone de type diamant, de l'argent, de l'aluminium, du nitrure d'aluminium, du graphène ou du cuivre, et la couche à haute conductivité thermique (301) a une épaisseur de 1 à 1000 nm.

8. Procédé de fabrication de l'affichage DELO selon la revendication 6, dans lequel le procédé avec lequel la couche d'encapsulation à film mince est formée comprend en outre :

Etape 25 : formation d'une seconde couche séparateur organique (402) sur la seconde couche de passivation inorganique (202) ; et
Étape 26 : dépôt et formation d'une troisième couche de passivation inorganique (203) sur la deuxième couche séparateur organique (402).

9. Procédé de fabrication de l'affichage DELO selon la revendication 8, dans lequel les première, deuxième et troisième couches de passivation inorganiques (201, 202, 203) sont chacune formées par PECVD, ALD, PLD ou pulvérisation ; les première, deuxième et troisième couches de passivation inorganiques (201, 202, 203) comprennent chacune un matériau qui comprend Al_2O_3 , TiO_2 , SiNx, SiCNx ou SiOx ; et les première, deuxième et troisième couches de passivation inorganiques (201, 202, 203) ont chacune une épaisseur de 0.5-μm;
dans lequel les première et deuxième couches séparateurs organiques (401, 402) sont chacune formées par impression à jet d'encre (IJP), PECVD, sérigraphie ou revêtement par fente ; les première et deuxième couches séparateurs organiques (401, 402) comprennent chacune un matériau qui comprend de l'hexaméthyldisiloxane, des polymères de polyacrylate, des polymères de polycarbonate ou du polystyrène ; et les première et deuxième couches séparateurs organiques (401, 402) ont chacune une

épaisseur de 4-8μm.

10. Procédé de fabrication de l'affichage DELO selon la revendication 6, dans lequel, dans le substrat DELO (101) fourni à l'étape 1, chacune des unités de pixel comprend quatre zones de sous-pixel agencées dans une matrice 2x2 et les quatre zones de sous-pixel sont respectivement des zones de sous-pixel blanches, rouges, bleues et vertes.

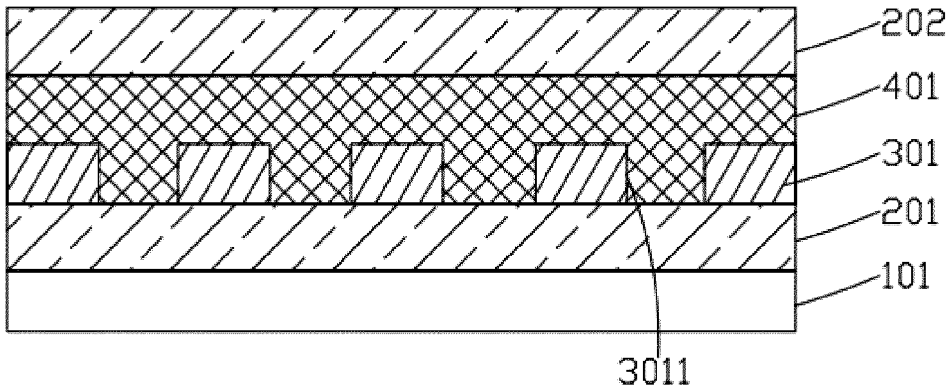

Fig. 1

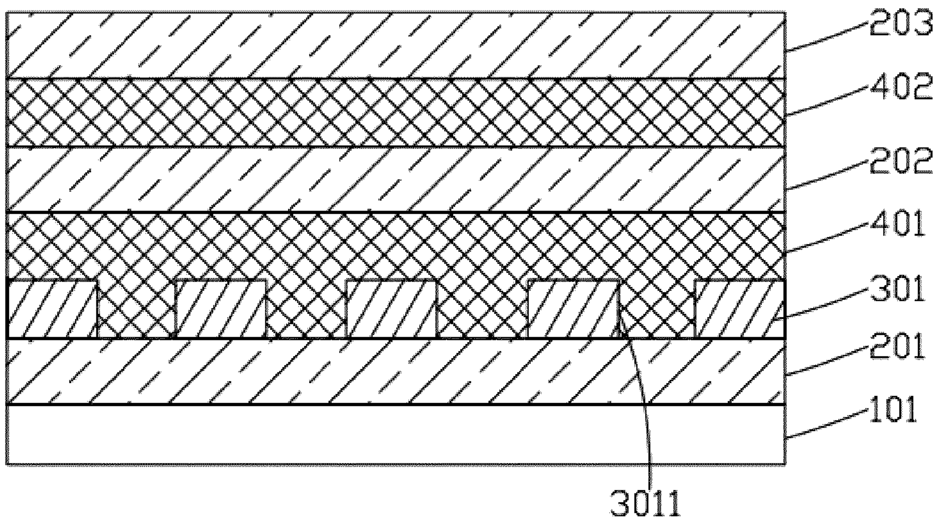

Fig. 2

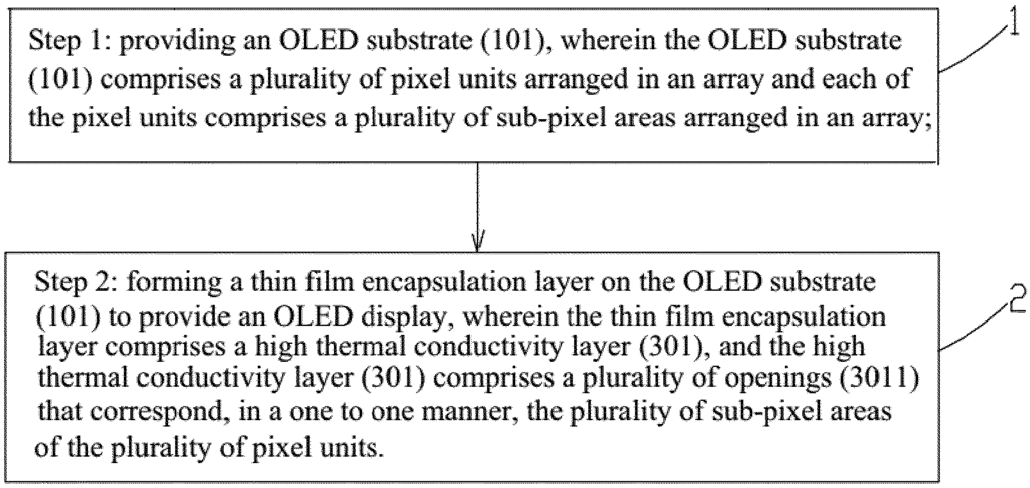

Fig. 3

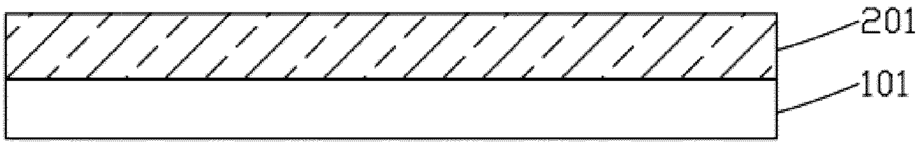

Fig. 4

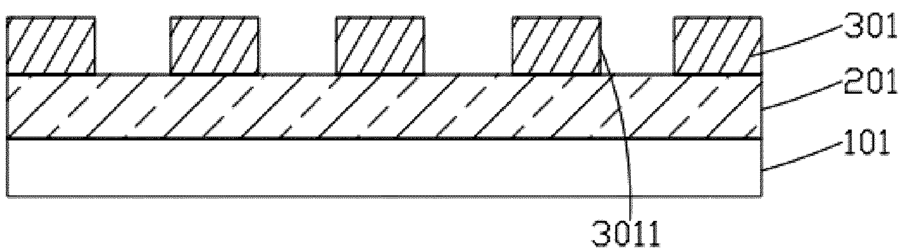

Fig. 5

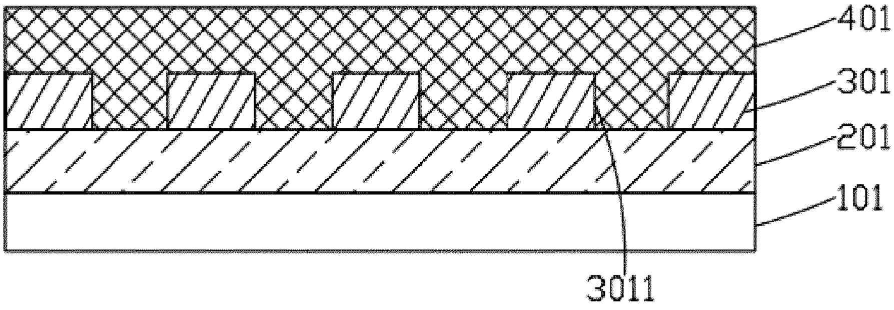

Fig. 6

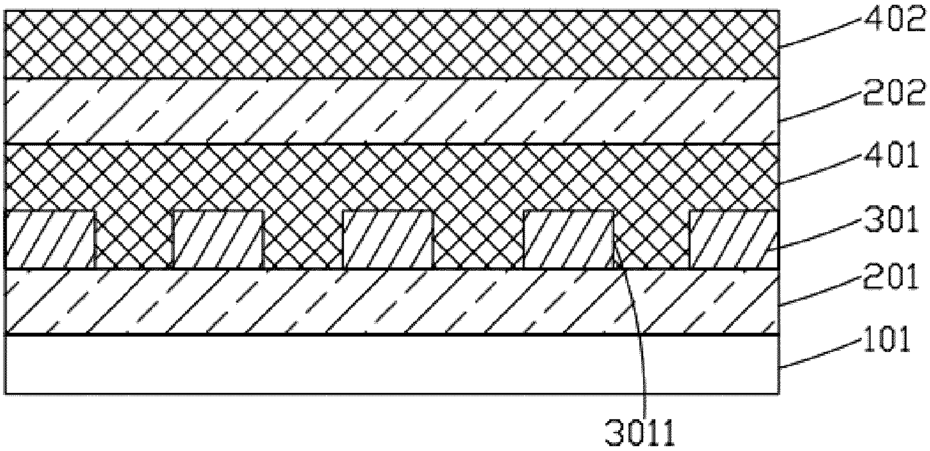

Fig. 7

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 8569951 B2 **[0005]**
- US 20090252975 A1 **[0005]**
- US 20150188084 A1 **[0005]**
- US 20150153779 A1 **[0005]**
- US 20150079707 A1 **[0005]**
- JP 2006259307 A **[0007]**

Non-patent literature cited in the description

- *Journal of Information Display* **[0007]**